APPENDICES

APPENDIX A

Glossary of Terms

Buffer Zone: A defined and delineated space on a landscape established by wildlife managers to prevent contact and disease transmission between wild sheep and domestic sheep and goats across that geographic space.

Bighorn Sheep: A member of the species *Ovis canadensis* found throughout the mountains of western North America. They occur from the Peace River in Canada to northern Mexico and east to the Badlands of the Dakotas. Eight races are reported if one counts the extinct Audubon's bighorn.

Contact: Direct contact or close proximity between body parts of two animals during which a disease might be transmitted from one to another. In this document, "contact" typically refers to nose-to-nose or face-to-face interaction that may lead to the transmission of respiratory disease via secretions or aerosols. Synonymous with "Interaction".

Die-off: A large-scale mortality event that impacts many animals from a population and may have significant demographic consequence to the long-term persistence of that population. In this report, such mortality events are usually caused by respiratory disease epidemics involving bacterial and/or other pathogens alone or in various combinations.

Disease: The word disease means literally "free of ease". Disease is any impairment that modifies or interferes with normal functions of an animal, including responses to environmental factors such as nutrition, toxicants, and climate. Typically, disease involves transmission of and exposure to some infectious agent, but it may involve noninfectious causes such as congenital defects.

Double Fencing: Two fences running parallel around a landscape or pasture to prevent contact between animals across the fence line, designed to inhibit disease transmission.

Effective Population Size: The average size of a population in terms of the number of individuals that can contribute genes equally to the next generation. The effective population size is usually smaller than the actual size of the population.

Effective Separation: Spatial and/or temporal separation between wild sheep and domestic sheep and goats resulting in minimal to no risk of contact and subsequent transmission of respiratory disease between animal groups.

Enzootic: Endemic in animals. An enzootic disease is constantly present in an animal population, but usually only affects a small number of animals at any one time.

Epizootic: An epizootic is a disease that appears as new cases in a given animal population, during a given period, at a rate that substantially exceeds what is "expected" based on recent experience (i.e., a sharp elevation in the incidence rate). Epidemic is the analogous term applied to human populations. High population density is a major contributing factor to epizootics.

Feral: An animal of a domestic species that resides in a non-domestic setting and is not presently owned or controlled.

Founder Effect: In population genetics, the founder effect is the loss of genetic variation that occurs when a new population is established by a very small number of individuals from a larger population. The founder effect is a special case of genetic drift. In addition to founder effects, the new population is often a very small population and so shows increased sensitivity to genetic drift, an increase in inbreeding and relatively low genetic variation.

Genetic Drift: Genetic drift is the random change in the genetic composition of a population due to chance events causing unequal participation of individuals in producing succeeding generations. Along with natural selection, genetic drift is a principal force in evolution.

Interaction: Direct contact or close proximity between body parts of two animals during which a disease might be transmitted from one to another. In this document, "interaction" typically refers to nose-to-nose or face-to-face interaction that may lead to the transmission of respiratory disease via secretions or aerosols. Synonymous with "Contact".

Metapopulation: A metapopulation consists of a group of spatially separated populations of the same species that interact at some level. A metapopulation is generally considered to consist of several distinct populations together with areas of suitable habitat that are currently unoccupied.

Minimum Viable Population: A minimum viable population is the smallest isolated population having at least a 95% probability of surviving at least 100 years (Shaffer 1983).

Migration or Migratory: A term used to refer to the movement of individuals or genes (gene flow) across a landscape; typically refers to movements from one seasonal habitat to another, or between breeding and nonbreeding habitats.

Population Bottleneck: A population bottleneck (or genetic bottleneck) is an evolutuonary event in which a significant percentage age of a population or species is killed or otherwise prevented from reproducing. Population bottlenecks increase genetic drift, as the rate of drift is inversely proportional to the population size. They also increase inbreeding due to the reduced pool of possible mates.

Risk/Risk Assessment/Risk Management: In this context, evaluation of the probability that a wild sheep population could experience a disease event with subsequent demographic impacts. Identification of what factors might contribute to the probability of a disease event. Management actions taken to reduce the probability of exposure and/or infection among, or between, animals. Examples of risk management include separation of infected and noninfected animals, treatment of infected individuals, vaccination, manipulations of the host environment, or manipulations of the host population.

Spatial Separation: A defined physical distance between animal populations.

Stray: A domestic sheep or goat physically or temporally separated from its associated flock or band.

Stressor: A specific action or condition that causes an animal to experience stress and the subsequent physiological results of that stress.

Temporal Separation: Segregating animal populations over time to prevent contact, such that they may occupy the same physical space but at different times.

Transmission: The physical transfer (direct or indirect mechanisms) of a disease agent from one animal to another, either within an animal population or between animal populations. In some instances, transmission can lead to full expression of disease in individuals or populations.

Trailing: The planned ambulatory movement of domestic sheep and goats across a landscape or within a corridor to reach a destination where grazing or use will be allowed.

Viability: The demographic and genetic status of an animal population whereby long-term persistence is likely.

APPENDIX B

Listing of Montana Bighorn Sheep Research Compiled by Glenn L. Erickson January 2008

Behavior:

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APPENDIX C

Transplant history of bighorn sheep in Montana, 1922-2009.

Year	Source	Number	Release Location
1922	Banff, Alberta, Canada	12	National Bison Range, Lake Co.
1939	National Bison Range, Lake Co.	23	Hart Mountain Refuge, Oregon[1]
	National Bison Range, Lake Co.	2	Washington State University, Pullman (for research)
	Mission Mtns., Missoula Co.	2	Wildhorse Island, Lake Co.
1942	Sun River, Teton Co.	11	Gates of the Mountains, Lewis & Clark Co.
1943	Sun River, Teton Co.	3	Gates of the Mountains, Lewis & Clark Co.
1944	West Gallatin, Gallatin Co.	1	Sun River, Teton Co.
	Ural-Tweed, Lincoln Co.	2	West Gallatin River, Gallatin Co.
1947	Sun River, Teton Co.	2	West Gallatin River, Gallatin Co.
	Sun River, Teton Co.	6	Wildhorse Island, Lake Co.
	Colorado, Tarryall herd, Park Co.	16	Billy Cr. Missouri River Breaks, Garfield Co.
1954	Sun River, Teton Co.	6	16 Mile Canyon, Gallatin Co.
	Wildhorse Island, Lake Co.	12	Kootenai Falls, Lincoln Co.
1955	Wildhorse Island, Lake Co.	9	16 Mile Canyon, Gallatin Co.
	Wildhorse Island, Lake Co.	8	Bull Mtn., Jefferson Co.
	Wildhorse Island, Lake Co.	4	Kootenai River, Lincoln Co.
	Sun River, Teton Co.	3	Bull Mtn., Jefferson Co.
1956	Sun River, Teton Co.	13	Sheep Cr., Cascade Co.
	No source available	1 to 4	National Zoological Park, Washington, D.C.
1957	Sun River, Teton Co.	7	Bull Mtn., Jefferson Co.
	Wildhorse Island, Lake Co.	6	Bull Mtn., Jefferson Co.
1958	Wildhorse Island, Lake Co.	5	Sheep Cr., Cascade Co.
	Sun River, Teton Co.	9	Two Calf Cr., Missouri River Breaks, Fergus Co.
	Wildhorse Island, Lake Co.	7	Blue Hills, Custer Co.
	Sun River, Teton Co.	5	Blue Hills, Custer Co.
1959	Sun River, Teton Co.	13	Eddy Cr., Sanders Co.
	Wildhorse Island, Lake Co.	6	Thompson River, Sanders Co.
	National Bison Range, Lake Co.	13	Two Calf Cr., Missouri River Breaks, Fergus Co.

Appendix C. Continued

1960	National Bison Range, Lake Co.	34	Stickney Cr. Big Belt Mtns., Lewis & Clark Co.
	National Bison Range, Lake Co.	11	Two Calf Cr., Missouri River Breaks, Fergus Co.
	Sun River, Teton Co.	8	Hannan Gulch, Sun River, Teton Co.
	Sun River, Teton Co.	3	Sheep Cr. Big Belt Mtns., Cascade Co.
1961	Sun River, Teton Co.	12	Two Calf Cr., Missouri River Breaks, Fergus Co.
1962	Sun River, Teton Co.	18	Sheep Cr. Little Belts Mtns., Meagher Co.
1963	National Bison Range, Lake Co.	5 (rams)	Ural-Tweed, Lincoln Co.
	National Bison Range, Lake Co.	6 (rams)	West Gallatin River, Gallatin Co.
	National Bison Range, Lake Co.	14	Doris Mtn., Flathead Co.
1964	Sun River, Teton Co.	25	Willow Cr. Tobacco Root Mtns., Madison Co.
1967	Sun River, Teton Co.	22	Highland Mtns., Silver Bow Co.
	Sun River, Teton Co.	25	Olson and Foster Cr., Deer Lodge Co.
1968	Sun River, Teton Co.	32	Prickly Pear Cr., Lewis & Clark Co.
	Sun River, Teton Co.	2	Stillwater River, Beartooth Mtns., Stillwater Co.
	Sun River, Teton Co.	16	Petty Cr., Missoula Co.
	National Bison Range, Lake Co.	15	Teakettle Mtn., Flathead Co.
1969	Sun River, Teton Co.	18	Highland Mtns., Silver Bow Co.
	Wildhorse Island, Lake Co.	23	Berray Mtn., Cabinets Mts, Sanders Co.
	Sun River, Teton Co.	13	Highland Mtns., Silver Bow Co.
1970	Sun River, Teton Co.	2	Stillwater River, Beartooth Mtns., Stillwater Co.
1971	Sun River, Teton Co.	35	Pryor Mtns., Carbon Co.
	Ford Cr., Lewis & Clark Co.	5	Beartooth Game Range, Big Belt Mtns., Lewis & Clark Co.
	Sun River, Teton Co.	36	Beartooth Game Range, Big Belt Mtns., Lewis & Clark Co.
	Ford Cr., Lewis & Clark Co.	8	Beartooth Game Range, Big Belt Mtns., Lewis & Clark Co.
	Sun River, Teton Co.	3	State Veterinary Laboratory, Gallatin Co. (for research)
1972	Sun River, Teton Co.	19	East Fork Bitteroot River, Ravalli Co.
	Sun River, Teton Co.	16	East Fork Bitteroot River, Ravalli Co.
	Ford Cr., Lewis & Clark Co.	21	Little Rockies, Phillips Co.
1973	Sun River, Teton Co.	5	Beartooth Game Range, Big Belt Mtns., Lewis & Clark Co.
	Sun River, Teton Co.	6	State Veterinary Laboratory, Gallatin Co. (for research)

Appendix C. Continued

1974	Sun River, Teton Co.	27	Pryor Mtns., Carbon Co.
	Sun River, Teton Co.	21	Little Rocky Mtns., Phillips Co.
	Sun River, Teton Co.	18	Pryor Mtns., Carbon Co.
1975	Sun River, Teton Co.	31	Rock Cr., Granite Co.
	Ford Cr., Lewis & Clark Co.	31	Berray Mtn., Sanders Co.
	Sun River, Teton Co.	11	Beartooth Game Range, Big Belt Mtns., Lewis & Clark Co.
	Sun River, Teton Co.	47	Beartooth Game Range, Big Belt Mtns., Lewis & Clark Co.
	Wildhorse Island, Lake Co.	2	Berray Mtn., Sanders Co.
1976	Sun River, Teton Co.	25	Blue Hills, Custer Co.
	Sun River, Teton Co.	39	Sheep Cr., Pondera Co.
1979	Wildhorse Island, Lake Co.	41	14 Mile Cr.,Sanders Co.
	Wildhorse Island, Lake Co.	25	Rock Cr., Granite Co.
	Wildhorse Island, Lake Co.	18	Washington State University, Pullman, WA
	Wildhorse Island, Lake Co.	14	Flathead Indian Reservation, Little Money, Sanders Co.
	Wildhorse Island, Lake Co.	11	Flathead Indian Reservation, Sanders Co.
1980	Sun River, Teton Co.	28	Missouri River Breaks, Fergus Co.
	Sun River, Teton Co.	28	Missouri River Breaks, Phillips Co.
1981	Wildhorse Island, Lake Co.	5	14 Mile Cr., Sanders Co.
1982	Sun River, Teton Co.	13	Washington State University, Pullman, WA (for research)
1984	Rock Creek, Granite Co.	1	release location unknown
	National Bison Range, Lake Co.	3	Stillwater River, Beartooth Mtns., Stillwater Co.
1985	National Bison Range, Lake Co.	4	Petty Cr., Missoula Co.
	Thompson Falls, Sanders Co.	2	Lost Cr., Deer Lodge Co.
	Thompson Falls, Sanders Co.	7	Mill Cr. Absaroka Mtns., Stillwater Co.
	Lost Creek, Deerlodge Co. and Rock Cr, Granite Co.	23	Boulder River, Absaroka Mtns., Park Co.
	Lost Creek, Deerlodge Co.	39	Tendoy Mtns., Beaverhead Co.
	Cinnabar Mtn., Park Co.	13	Mill Cr. Absaroka Mtns., Park Co.
	Thompson Falls, Sanders Co.	2	National Bison Range, Lake Co.
1986	Thompson Falls, Sanders Co.	14	Tendoy Mtns., Beaverhead Co.

Appendix C. Continued

1987	Lost Creek, Deerlodge Co.	28	Ranch Cr., Granite Co.
	Lost Creek, Deerlodge Co.	12	Boulder River, Absaroka Mtns., Park Co.
	Upper Rock Cr., Granite Co.	7	Boulder River, Absaroka Mtns., Park Co.
	Ural-Tweed, Lincoln Co.	2	Wildhorse Island, Lake Co.
	Upper Rock Cr., Granite Co.	14	Bonner, Missoula Co.
1988	Thompson Falls, Sanders Co.	19	Squaw Cr., Madison Co.
1989	Lost Creek, Deerlodge Co.	25	Boulder River, Absaroka Mtns., Park Co.
	Thompson Falls, Sanders Co.	5	Quake Lake, Hilgard Peak, Madison Co.
	Lost Creek, Deerlodge Co.	19	Taylor and Hilgard Peaks, Gallatin Co.
	Sun River, Teton Co.	7	Joseph, Washington
1990	Sun River, Teton Co.	38	Painted Rock, Bitteroot Mtns., Ravalli Co.
	Sun River, Teton Co.	30	Bonner, Missoula Co.
1991	Lost Creek, Deerlodge Co.	32	Blackleaf Canyon, Teton Co.
	Lost Creek, Deerlodge Co.	28	West Fork Bitterroot River, Bitterroot Mtns., Ravalli Co.
1992	Highland Mtns., Silver Bow Co.	35	Sleeping Giant, Big Belt Mtns., Lewis & Clark Co.
1993	Wildhorse Island, Lake Co.	32	Sleeping Giant, Big Belt Mtns., Lewis & Clark Co.
	Wildhorse Island, Lake Co.	15	Blackleaf Canyon, Teton Co.
	Wildhorse Island, Lake Co.	26	Little Mile Cr., Gallatin Co.
	Wildhorse Island, Lake Co.	8	Washington State University, Pullman (for research)
	Thompson Falls, Sanders Co.	3	National Bison Range, Lake Co.
1994	Wildhorse Island, Lake Co.	47	Oregon (2 sites)
1995	Perma, Sanders Co.	19	Beartooth WMA[2], Lewis & Clark Co. and Cascade Co.
	Perma, Sanders Co.	26	Boulder River, Sweet Grass Co.
1996	Rock Creek, Granite Co.	20	Beartooth WMA, Lewis & Clark Co. and Cascade Co.
	Rock Creek, Granite Co.	25	Elkhorn Mtns., Broadwater Co.
1997	Milltown, Missoula Co.	30	Elkhorn Mtns., Broadwater Co.
	Rock Creek, Granite Co.	19	Tendoy Mtns., Beaverhead Co.
	Rock Creek, Granite Co.	30	Boulder River, Sweet Grass Co.
1998	Bitterroot Mtns., Ravalli Co.	22	Deep Cr., Teton Co.

Appendix C. Continued

2000	Missouri River Breaks, Blaine Co. and Fergus Co.	20	Elkhorn Mtns., Broadwater Co.
	Thompson Falls, Sanders Co.	16	Kootenai Falls, Lincoln Co.
	Sun River, Teton Co.	27	Sapphire, Mtns., Ravalli Co.
2001	Sun River, Teton Co.	32	Highland Mtns., Silver Bow Co.
	Bonner, Missoula Co.	3	Highland Mtns., Silver Bow Co.
2002	Missouri River Breaks, Blaine Co.	20	Idaho/Oregon Hells Canyon
	Sula, Ravalli Co.	23	Utah
	Sula, Ravalli Co.	14	Highland Mtns., Silver Bow Co.
	Sun River, Teton Co.	30	Tendoy Mtns., Beaverhead Co.
2003	Missouri River Breaks, Blaine Co.	30	Greenhorn Mtns., Madison Co.
	Bonner, Missoula Co.	2	Kootenai Falls, Lincoln Co.
2004	Sun River, Lewis & Clark Co.	24	Kootenai Falls, Lincoln Co.
	Sun River, Teton Co.	39	Greenhorn Mtns., Madison Co.
	Sun River, Lewis & Clark Co.	10	Bitterroot Mtns., Ravalli Co.
	Bitterroot Mtns., Ravalli Co.	12	Sheep potentially infected with *Brucella ovis*, Colorado[3] (for research)
	Thompson Falls, Sanders Co.	35	Utah, Flaming Gorge
2006	Missouri River Breaks, Phillips Co.	19	North Dakota, Little Missouri River
	Missouri River Breaks, Blaine Co.	20	Wyoming, Big Horn Mountains
	Ten Lakes, Lincoln Co.	2	Ural-Tweed, Lincoln Co.
2007	Sun River, Teton Co.	32	Nebraska
	Sun River, Lewis & Clark Co.	30	Utah
	Missouri River Breaks, Blaine Co.	20	North Dakota
	Missouri River Breaks, Blaine Co.	20	Nebraska
	Ruby Mountains, Madison Co.	18	Highland Mtns., Silver Bow Co.
	Plains, Sanders Co.	42	Wyoming (Laramie Peak)
	Bonner, Missoula Co.	27	Utah
	Rock Creek, Granite Co.	15	Utah
	E. Fk. Bitterrrot River, Ravalli Co.	25	Utah

2008	McCarty Hill/Ford Cr., Lewis & Clark Co.	18	Soap Gulch, Highland Mtns., Silver Bow Co.
	Willow Cr./ Ford Cr., Lewis & Clark Co.	13	Soap Gulch, Highland Mtns., Silver Bow Co.
	Sun Canyon /Castle Reef, Teton Co.	24	Camp Cr., Highland Mtns., Silver Bow Co.
	Mortimer & Big George Gulch, Teton Co.	10	Camp Cr., Highland Mtns., Silver Bow Co.
	Wildhorse Island, Lake Co.	38	Kootenai Falls, Lincoln Co.
	Flathead Indian Reservation, Lake Co.	24	Rocky Boys Indian Reservation, Hill Co. and Chouteau Co.
2009	Willow Cr./Ford.Cr., Lewis & Clark Co.	30	Utah
	Sun Canyon/Gibson Res., Teton Co.	30	Utah
Sheep Transplants: Summary			
	Total sheep trapped within Montana	2,067	for transplants within Montana
	Total sheep trapped within Montana	465	for transplants outside of Montana
	Total sheep trapped outside of Montana	28	for transplants to Montana
	Total sheep trapped (management)	2,560	transplanted for restoration or augmentation
	Total sheep trapped (special)	66	for research studies and zoos

[1] Kraft, E. 2006. Untold Tales of Bison Range Trails. Stoneydale Press, Stevensville, MT. Pp 24-25.
[2] Wildlife Management Area
[3] Sent to Colorado as part of a bighorn stress/disease study.
Note: The National Bison Range has exchanged rams with other "parks, private refuges and agencies" over the years. Kraft, E. 2006. Untold Tales of Bison Range Trails. Stoneydale Press, Stevensville, MT. Pp 34-35.

APPENDIX D

Money generated from the annual auction of a bighorn sheep license, 1986-2009.

Year	Amount
1986	79,000
1987	109,000
1988	93,000
1989	74,000
1990	61,000
1991	80,000
1992	88,000
1993	205,000
1994	310,000
1995	281,000
1996	220,000
1997	238,000
1998	300,000
1999	130,000
2000	95,000
2001	100,000
2002	90,000
2003	132,500
2004	160,000
2005	160,000
2006	115,000
2007	140,000
2008	195,000
2009	245,000
Total	3,700,500

The 49th Montana legislature provided the FWP Commission authority under Title 87-2-722 to auction one bighorn sheep license each year. A wildlife conservation organization is given the authority by the Commission to conduct the auction and may retain up to 10% of the proceeds. All remaining proceeds from the auction must be used for the substantial benefit of mountain sheep. Auction funds must be used in conjunction with any other funds the department uses for the management of bighorn sheep.

The primary uses of the funds generated by the auction of a bighorn license have included funding translocation of bighorns within Montana, aerial survey and monitoring efforts, habitat acquisition and easements, several research projects including a number of graduate studies and habitat enhancement projects on private and public lands.

APPENDIX E

Bighorn Sheep Transplant Site Assessment Form

Fill out the following list of items as the various aspects of the potential transplant site are quantified according to the Habitat Evaluation Procedure (HEP) in the Translocation Section. Attach a map showing the potential site, including the overall area, potential lambing habitat, summer range and winter range.

1) Is this potential transplant site to your knowledge historical bighorn sheep habitat?

2) Are there any existing bighorn sheep populations in the vicinity? Yes No (circle one). If yes, what is the name of the population, distance to it, and the likelihood for interchange assuming the establishment of a new population?

   a. Name of nearest bighorn sheep population _____
   b. Distance from core habitat _____
   c. Likelihood of interchange: High Medium Low Unknown (circle one)

3) Are there any significant barriers to movement that need to be considered and if there are provide details and suggested mitigations if any ? For example: prescribed burn to open up migration corridors where conifers are establishing on former grasslands.

4) Based on your assessment of escape terrain in the entire potential area as described in the HEP (item 1) is there enough suitable habitat to support a MVP of 125 animals? What is the total estimated size of potential habitat from this analysis? If the area can support more animals what would be the estimate of total number of bighorn sheep the area could support at the appropriate density (see Translocation Section for densities in relation to habitat type)?

   a. Is there suitable habitat for MVP – Yes No (circle one)
   b. Size of potential habitat _____ km2/mi2
   c. Total number of bighorns the area can support _____

5) Based on your assessment of potential winter range as described in the HEP (item 2) is there enough suitable habitat to support a MVP of 125 animals? What is the total estimated size of potential winter range habitat from this analysis? If the area can support more animals because of the size of potential winter range habitat what would be the estimate of total number of bighorn sheep the area could support at the suggested maximum density of 20 bighorn sheep /km2?

   a. Is there suitable winter habitat for MVP – Yes No (circle one)
   b. Size of potential winter habitat _____ km2/mi2
   c. Total number of bighorns the area can support _____

6) Based on your assessment of potential lambing habitat range as described above in the HEP (item 3) is there enough suitable habitat to support a MVP of 125 animals? What is the total estimated size of potential lambing habitat from this analysis? If the area can support more animals because of the size of potential lambing habitat what would be the estimate of total number of bighorn sheep the area could support at the suggested amount of habitat (6 ha) required for each lambing ewe?

   a. Is there suitable lambing habitat for MVP – Yes /No (circle one)
   b. Size of potential lambing habitat _____ km2/mi2
   c. Total number of bighorns the area can support _____

7) Based on your assessment of potential summer range as described in the HEP (item 4) is there enough suitable habitat to support a MVP of 125 animals? What is the total estimated size of potential summer range habitat from this analysis? If the area can support more animals because of the size of potential summer range habitat what would be the estimate of total

number of bighorn sheep the area could support at the suggested amount of habitat (8.4 – 9.7 km2) required to support the 65 – 75 nonbreeding bighorn sheep?

a. Is there suitable summer habitat for MVP – Yes No (circle one)
b. Size of potential summer habitat _____ km2/mi2
c. Total number of bighorns the area can support _____

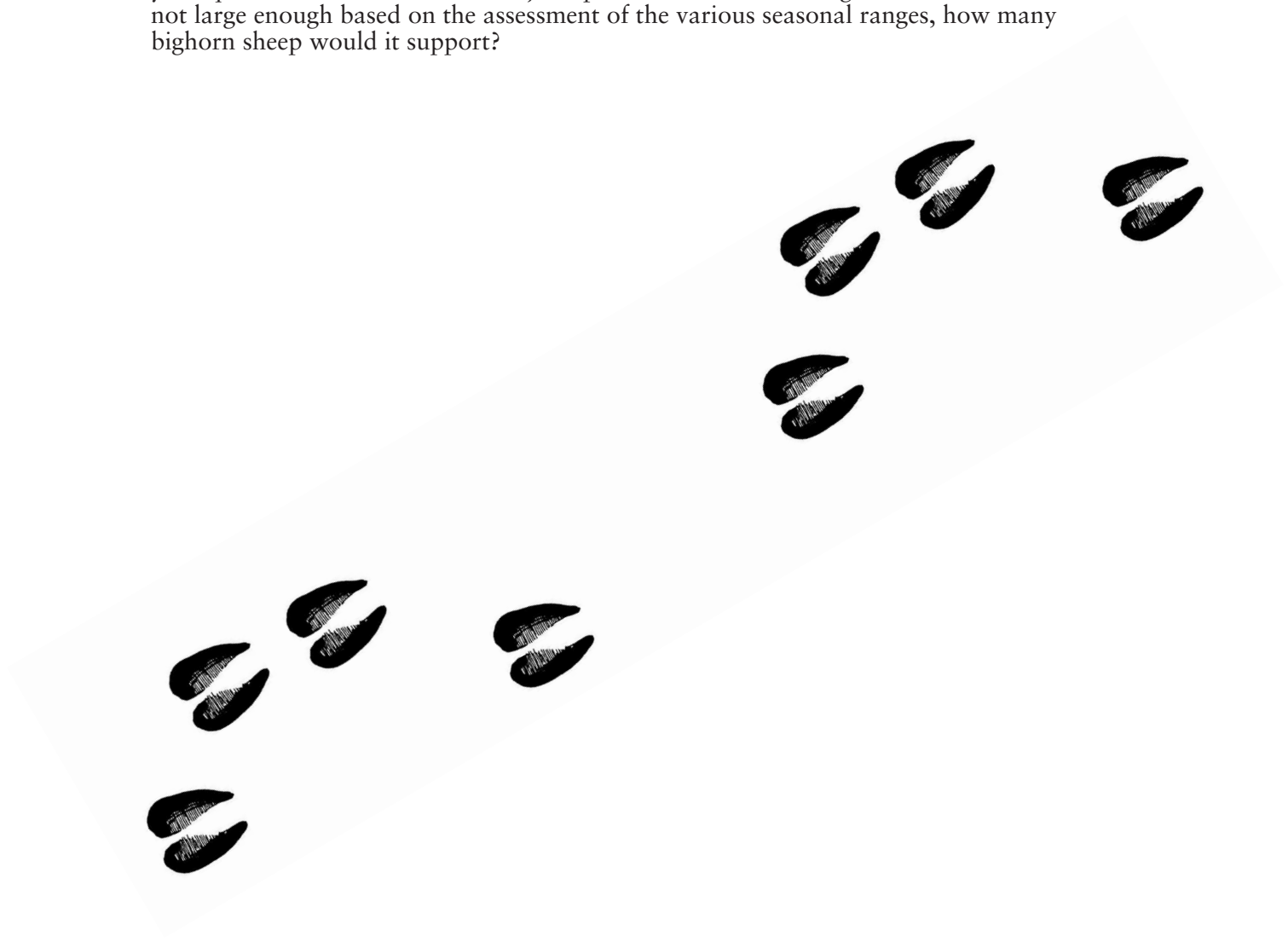
8) Are there domestic sheep or goats near this site? If so approximately how many and what would be their distance from the habitat to be potentially occupied by bighorn sheep? Are the domestic animals located on private or public lands? Is there opportunity for spatial/temporal separation based on minimum suggested distance of 23 km, effective physical barriers or other mitigating facors (provide description in (item c) below?

a. Number of domestic sheep and goats and distance to potential bighorn habitat_____
b. Located on Private or Public lands (describe): _____
c. Opportunity for separation:

9) Based on the overall assessment of seasonal ranges the highest estimated number of bighorn sheep the area would be expected to sustain would be the lowest number of any of the seasonal ranges. What is the maximum number of bighorn sheep the area will support?

a. Maximum estimated number of bighorns the area can support _____

10) Assuming there is adequate habitat to support an MVP of bighorn sheep what is your qualitative assessment on the juxtaposition of seasonal ranges. If the area is not large enough based on the assessment of the various seasonal ranges, how many bighorn sheep would it support?



APPENDIX F

Biomedical Protocol For Free-Ranging Bighorn Sheep (*Ovis Canadensis*) In Montana:

Capture, anesthesia, tagging, sampling, transportation, and necropsy procedures.

Montana Fish, Wildlife & Parks

Research Laboratory
1400 South 19th
Bozeman, Montana

General

Capture and chemical immobilization of free-ranging bighorn sheep should be carried out by a team of professionals with proper training, experience, and expertise in wildlife capture, veterinary anesthesia, and animal handling. Capture data should be recorded on the standard Wildlife Immobilization Form. In Montana, adult body weights vary from ~70 kg (150 lbs) in females to ~110 kg (240 lbs) in males. Three-month-old lambs weigh ~23 kg (50 lbs). The rut typically occurs mid-November to late December. Gestation lasts 174 days, thus lambing usually occurs in the spring (mid-May to late June). Capture during the last trimester of pregnancy (mid-March onward) should be avoided whenever possible.

Legal Considerations

The purpose of the Montana FWP Animal care and Use Committee (FWP-ACUC) is to facilitate utilization of free-ranging wildlife in Montana for scientific study in accordance with the U.S. Department of Agriculture Animal Welfare Act. To this end, all requests (internal and external)for scholarly study of wildlife in Montana must be submitted to and approved by the FWP-ACUC.

Physical Immobilization

The net-gun has been found to have considerable advantages over the use of ground nets and chemical immobilization methods for capturing bighorn sheep. In a study by Kock et al (1987), the use of the net-gun resulted in the lowest proportion of compromised sheep at 11%, had no capture myopathy (CM) mortality, and resulted in a 2% accidental mortality. The use of drop-nets resulted in 15% compromised sheep, a CM mortality rate of 2%, and an accidental mortality rate of 1%. A similar proportion of sheep were compromised with drive-nets (16%). This method also had the highest CM mortality rate at 3%, and an accidental mortality rate of less than 1%. Chemical immobilization resulted in the most compromised sheep at 19%, had a CM mortality rate of 2%, and caused the most

accidental deaths at 6%. Drop-nets and drive-nets were comparable when combining total mortality with rates for compromised bighorn sheep, 18% and 19%, respectively. Chemical immobilization had the highest combined measure of risk at 27% and net-gun lowest at 12%.

The use of blindfolds and hobbles is necessary to reduce stress and possible injury. Bighorn sheep should be kept sternal whenever possible. Handling, lifting, or moving animals should be done in a manner that reduces the potential for injury to joints and the neck. Lifting animals by the head, neck, or individual legs is not acceptable and may result in injury. Bighorn sheep captured during net-gun operations and requiring the use of a helicopter to transfer sheep should be kept sternal. The use of a "transport bag" slung under the helicopter or placement of sheep inside the helicopter are both suitable options. Slinging bighorn sheep by hobbled legs and upside down may be necessary in certain situations but should be minimized to reduce the possibility of aspiration of rumen content. If required, slinging bighorn sheep upside down under a helicopter should be limited to distances of less than ½ mile.

Chemical Immobilization

Bighorn sheep may be immobilized by darting them from the ground or from a helicopter. Anesthesia is similar to that used with other ungulate species; however, careless use of immobilization drugs in bighorn sheep can contribute to hyperthermia, cardiac dysfunction, respiratory depression, lowered blood pressure, localized blood pooling, acidosis, bloat, and aspiration. The most common complications encountered during anesthesia are respiratory depression, hyperthermia, and bloat. Capture stress and/or capture myopathy are potentially serious complications that can be very difficult to treat in a field situation. Treatment is often unsuccessful.

There are several immobilizing drug choices for anesthesia of bighorn sheep:

1) Carfentanil ~0.045 mg/kg + ~0.2 mg/kg xylazine has been shown to produce reliable immobilization. A total adult dose of 3.5 – 4.5 mg carfentanil with 15 – 20 mg xylazine provides rapid induction and safe anesthesia. Antagonism using 100 mg of naltrexone/mg of carfentanil given both IM and IV to reduce the possibility of renarcotization. Xylazine may be antagonized with 1.0 – 3.0 mg/kg tolazoline given slowly IV.

2) Etorphine (M99®) is another opioid suitable for immobilizing free-ranging bighorn sheep. A total adult dose of 4.5 - 5 mg combined with 20 mg xylazine provides rapid induction and safe anesthesia. It is important not to under dose when using potent opioids as immobilization agents. Antagonism with naltrexone at 50.0 mg/mg etorphine used, given both IM and IV to reduce the possibility of renarcotization. Xylazine may be antagonized with 1.0 – 3.0 mg/kg tolazoline given slowly IV.

3) Medetomidine + ketamine is a reasonable non-opioid alternative for field immobilization of bighorn sheep that have not been stressed. A combination of 0.05 mg/kg medetomidine + 2 mg/kg ketamine provides reliable anesthesia. Induction may be prolonged, is adversely affected by noisy or stressful conditions and a period of 10 to 15 minutes after recumbency must elapse before the animal is handled. Antagonize with atipamezole at 5:1 dose of medetomidine administered or at 0.25 mg/kg.

4) 0.3 mg/kg of xylazine + 2.5 mg/kg of Telazol® may also provide reliable immobilization in calm animals, avoiding the use of potent opioids. The xylazine should be antagonized with 1.0 – 3.0 mg/kg tolazoline administered slowly IV. This combination may not be appropriate for immobilizing stressed animals, and due to extended recovery times is generally not recommended.

5) 1 mg/kg xylazine + 4 mg/kg ketamine. Xylazine may be antagonized with 1.0 – 3.0 mg/kg tolazoline administered slowly IV. Least appropriate option.

Withdrawal periods must be observed in animals that may potentially be hunted for food and animals must be tagged for future identification. Consult the FWP Prescription Drug Acquisition and Use Protocol for withdrawal periods.

Additional doses for immobilization

Animals that are not recumbent 20 minutes after darting should be re-darted with a full dose. Animals showing obvious but incomplete drug effects may be darted with a half-dose. Opioids should never be under-dosed. In most

situations, anesthesia may be prolonged by administering a bolus of ketamine IV at a dose of 1 to 2 mg/kg every 15 to 20 minutes.

Adjunctive Therapy

At the discretion of the veterinarian, animals that are injured as a result of the immobilization process may receive prophylactic antibiotic therapy (Procaine + benzathene penicillin administered at 30,000 IU/kg IM). Animals captured for transplantation within Montana will be administered vitamin E, selenium, an antibiotic such as Florfenicol, and drugs to remove parasite loads such as Ivermectin. These adjunctive therapies may be administered to sheep captured for other reasons. Dosages of such drugs will be administered based on body size and recommendations stipulated on the vial. Changes to dosages may be made at the discretion of the veterinarian. Withdrawal periods of 30 days or more depending on drugs administered must be observed in animals that may potentially be hunted for food.

Handling of Immobilized Animals

Once the animal is recumbent, it should be approached with caution and with as little noise as possible. Eye covers should be placed on the animal immediately; they act as an additional means of restraint, protect the eyes, and can prolong and improve the effects of immobilization. Monitoring of vital signs should begin as soon as possible after recumbency. Respiration and oxygenation are the most critical indications of an animal's well- being under anesthesia, and pulse oximetry should be used as an adjunct to monitoring whenever possible. Cardiac monitoring is also important, especially in animals immobilized by one of the agents that can cause bradycardia or hypotension. Temperature monitoring and control is important too. Animals generate a significant amount of heat during the exertion of capture and once immobilized have no means with which to dissipate it.

Baseline body temperatures (BT), heart rates (HR), and respiratory rates (RR) have been recorded from chemically immobilized bighorn sheep (Franzmann, 1971; Kock, 1987). Stress, exertion, ambient temperature and capture technique are known to influence the values. Safe expected ranges at capture are: BT 39.1°C (102.4°F) to 41.2°C (106°F), HR 125 to 130 beats per minute (b/min), and RR 40 to 64 respirations per minute (r/min). These ranges incorporate all seasons and the use of a central nervous system depressant drug. Values considered critical and an indication that corrective action should be taken include: BT 41.5°C (106.7°F), HR 145 b/min, and RR 75 r/min. Persons trained in monitoring vital signs should be present during bighorn sheep capture and immobilization procedures.

In warm weather, elect to immobilize animals in the cooler periods of the day and use water to wet the animal down to increase cooling. Sheep are also prone to hyperthermia. In very cold conditions, be vigilant for evidence of hypothermia and be prepared to respond accordingly. Immobilized bighorn sheep are best placed in sternal recumbency to reduce the complications of bloat and regurgitation. As with all ruminants, the head should be elevated slightly above the level of the rumen to prevent regurgitation and the mouth should be slightly lower than the neck to allow saliva to drain. Ensure that the nostrils are clear and that the animal is breathing without difficulty. Remove the dart and needle and clean and treat the dart wound with topical antibiotic prior to reversing the immobilization and releasing the animal.

Tagging and Sampling

All animals will be ear-tagged using an identifying FWP plastic ear tag with a unique identifying number and the following printed on the back: "Call Before Eating". On occasion, bighorn sheep may be captured for radio-tagging or sampling purposes and should be processed according to the aim of the project. Neck bands or radio collars (VHF or GPS) should be fitted according to the size, age, and sex of the animal.

Body measurements should be recorded according to established protocols. Blood is collected from the jugular vein by needle and syringe or using the BD Vacutainer® system. To facilitate sampling, blood should be collected immediately after capture of the animal. A small area of the neck is prepared (swabbed with chlorhexidine in alcohol) to visualize the jugular vein. In adults, 2 x 8.5 ml serum separator tubes (SST, red/tiger top) and 1 x 3.0 ml K2EDTA tube (purple top) should be used. Up to 10% of the circulating blood volume can be taken on a single occasion from normal healthy (adult) animals on an adequate plane of nutrition with minimal adverse effect. The SST tubes should be protected from rapid cooling for at least one hour to ensure complete coagulation. Serum should then be separated by centrifugation (8,000 rpm for 10 minutes) and stored at –20°C (-4°F) in 2 ml cryogenic vials.

Where feasible, pharyngeal/tonsillar swabs (using Dacron-tipped polyester culture swabs and Port-A-Cul transport media, available

from the Wildlife Lab in Bozeman) should be collected for Pasteurella and Mycoplasma cultures. These swabs are to be shipped overnight, on ice to:

Dr. Glen Weiser
University of Idaho
Caine Veterinary Teaching Center
1020 E. Homedale Rd
Caldwell, ID 83607
208-454-8657

Hair (with roots) is sampled using pliers (transferred to a 2 ml cryogenic vial), two skin biopsies may be taken from the inside of an ear using a sterile 4 – 6 mm biopsy punch, and feces is collected from the rectum using latex gloves and then transferred to a sterile 15 ml plastic tube or Whirlpak. Additional biological materials should be sampled according to specific study protocols and follow accepted procedures. Hair and skin biopsies may be preserved in 96% ethanol. Feces are kept cool but not frozen for parasite analysis.

Euthanasia

Consistent with AVMA Panel on Euthanasia (2000) and as specified in the euthanasia guidelines of the FWP Prescription Drug Acquisition and Use Protocol.

Necropsy Procedures

In case of a capture-related mortality, the carcass should be transported to a veterinary diagnostic laboratory for a complete necropsy or, as an alternative, an affiliated veterinarian or biologist can perform a field necropsy after consultation with the laboratory.

Wildlife Laboratory

Department of Livestock
Montana Fish, Wildlife & Parks
Montana Veterinary Diagnostic Lab
1400 S. 19th Ave.
South 19th and Lincoln
Bozeman, MT 59718
406-994-6357
406-994-4885

To ensure rapid cooling, skinning the carcass and opening the abdominal cavity (while preserving the integrity of the organs) can be considered. If transportation to the laboratory is not possible within 24 to 48 hours, the carcass should be frozen.

Long Distance Transportation

If transportation of live animals is necessary, it must be conducted in a manner that produces the least amount of stress to the animals. Bighorn sheep should be held in suitable trailers ambulatory and able to see. Trailers specifically designed for transporting sheep are preferred. These trailers generally allow for the separation of sheep into small groups of four or less. Standard horse trailers can be used for moving sheep, but the insides of the trailers should be rounded with no square corners that allow sheep to congregate in one area. Floors of trailers should be lined with straw or other suitable material. All trailers should have adequate ventilation to allow for air transfer through the trailer, yet openings should be in locations or of small size to minimize the potential for injury to legs, heads, or other body parts that may become lodged in openings. Adult rams (more than three years old) should be separated from ewes and lambs when transporting. The maximum number of sheep in a trailer should not exceed 10 per 40 square feet of floor space (Foster 2005). Sheep held in trailers should be observed frequently but discretely to assess health status. Bighorn sheep should be transported as quickly as possible to release sites, minimizing their stay in trailers and reducing exposure to human disturbance.

Additional information regarding capture and transportation of wild sheep is available in the "Wild Sheep Capture Guidelines" sponsored by the Northern Wild Sheep and Goat Council and Desert Bighorn Council (Foster 2005).

Literature

1) Kock MD, Clark RK, Franti CE, Jessup DA, Wehausen JD. 1987. Effects of capture on biological parameters in free-ranging bighorn sheep (*Ovis canadensis*): evaluation of normal, stressed and mortality outcomes and documentation of post-capture survival. J Wildl Dis. 23(4):652-62.

2) Kock MD, Jessup DA, Clark RK, Franti CE. 1987. Effects of capture on biological parameters in free-ranging bighorn sheep (Ovis canadensis): evaluation of drop-net, drive-net, chemical immobilization and the net-gun. J Wildl Dis. 23(4):641-51.

3) Kock MD, Jessup DA, Clark RK, Franti CE, Weaver RA. 1987. Capture methods in five subspecies of free-ranging bighorn sheep: an evaluation of drop-net, drive-net, chemical immobilization and the net-gun. J Wildl Dis. 23(4):634-40.

4) Franzmann AW, Thorne ET. 1970. Physiologic values in wild bighorn sheep (*Ovis canadensis canadensis*) at capture, after handling, and after captivity. J Am Vet Med Assoc. 1;157(5):647-50.

5) Franzmann AW. 1971. Comparative physiologic values in captive and wild bighorn sheep. J Wildl Dis. 7(2):105-8.

6) Foster CL. 2005. Wild Sheep Capture Guidelines. Biennial Symposium of the Northern Wild Sheep and Goat Council. 14:211-282.

IACUC Approval

This biomedical protocol has been approved by the FWP Institutional Animal Care and Use Committee (IACUC) with the following stipulations:

1) Approval was granted for a five-year period ending December 2012.

2) IACUC approval applies to management activities only. All research activities will require additional IACUC review.

Capture or handling activities that do not follow methodologies stipulated in this protocol will be done without IACUC approval.

IACUC attending Members:

Tom Carlsen, Acting Chair
Ken Hamlin, FWP Research Biologist
Dr. Dave Hunter, DVM
Karin Jennings, Public Representative

Wildlife Division Approval

Methodologies presented in this document are to serve as the guidelines for bighorn sheep capture, handling, and transportation for management situations undertaken by Montana FWP. Variation from methodologies provided in this protocol should only be conducted under the guidance of the FWP wildlife veterinarian.

_____

Ken McDonald,
Wildlife Division Administrator

_____

Date

APPENDIX G

Bighorn Sheep Survey

DATE: __________ TIME: T.O.________ LAND: ________ TEMP: ______ CLOUDS:__________________
WIND: _______ PRECIP: ____________GROUND:_______________ OBSERVER:______PILOT:________
NOTES:____
____
____

WAYPT. NO.	LOCATION	TOTAL	EWES	LAMBS	RAMS (curl)				NOTES
					0-1/4	1/4-1/2	1/2-3/4	3/4+	